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Building Decision Adviser Bots

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ABSTRACT

This overview article explores the prospects and promises of new technologies for developing conversational software to aid, assist and advise people in personal and organizational decision situations. The quest for conversational decision advisers began in the 1970s with the development of interactive, computing systems like the Hewlett-Packard 2000 Access Time-Share systems. With the advent of Cloud-based, Artificial Intelligence development environments, the capabilities needed to develop conversational software are increasingly available and easy to use. Hence, it is feasible to develop decision adviser (DA) bots and the bots are easier to deploy. Bots can be built for action taking and for question and answer dialogs. DA bots can be deployed for use in both structured and semi-structured decision situations. DA bots can perform increasingly complex tasks. Overall, more exploratory design science research is needed to improve our understanding of the design, development, and deployment of DA bots for use by managers, customers, and clients.

Keywords

Artificial Intelligence, decision bots, bot design, bot use cases.

INTRODUCTION

Chatting using text, speech, natural language understanding, and computer-generated voice with an intelligent decision support adviser or assistant is now possible. A natural language user interface likely will replace and augment drop-down menus, drag and drop gestures, and even touch for many applications. Currently, a bot is most often a programmed application for simple, structured, repetitive action taking. Decision adviser (DA) bots can be designed to perform in more complex structured and semi-structured decision situations, provide decision support, and learn and improve the quality of the conversational interaction. For the near future, expect that chatting using voice and natural language with a decision adviser, a DA bot, will become common. A conversational DA bot may become the most powerful user interface ever built for decision support. Also, voice AI technology can and likely will improve the effectiveness of decision support.

A recent global market research report from analyst firm IDTechEx titled, "Voice, Speech, Conversation-Based User Interfaces 2019-2029: Technologies, Players, Markets", finds the market for smart speech/voice-based technology will reach $15.5 billion by 2029 (PR Newswire, 2018). Imitating human conversation using software is increasingly possible and realistic with tools like Alexa, Siri, Watson, and Google Assistant. Interactive voice response systems ask and answer questions. Also, these tools help you "tell" your digital assistant to do tasks, perform actions, and other "things". Robotic chat, voice AI, chatbots, talk bots, interactive agents, or other artificial conversational entities are computer programs that converse with a person using text or spoken prompts and replies. Conversation is most often specialized, highly structured, and with a focused narrow purpose. A number of companies and websites advertise and review chatbot/voice AI software for customer service or decision support. For example, Botlist.co, aws.amazon.com/lex, liveperson.com, lp.helpshift.com, and comm100.com. DA bots are a good example of human-centered automation where AI and software work cooperatively with people to achieve one or more defined objectives.

A “conversational interface” can be built using text message conversation or voice conversation. Both conversational types require natural language processing and understanding, but voice conversations also require speech recognition and processing. AI technologies have improved dramatically for both speech recognition and machine-generated speech. Bots also often include machine-learning capabilities that learn from data, identify patterns and make decisions with minimal human intervention.

The quest for conversational decision advisers and decision aids began in the 1970s with the development of interactive, computing systems like the Hewlett-Packard 2000 Access Time-Share systems (Power, 1977), personal computers, in the 2000s Web-based systems, and more recently smartphones. Development environments were limited and developers often wrote structured programs in languages like BASIC, JavaScript, and PHP. The advent of Cloud-based, Artificial Intelligence development environments has provided capabilities needed to develop powerful conversational software using speech. These development environments are increasingly available, and easy to use. Because of this technology advance, developing decision adviser (DA) bots is both feasible and much easier to deploy.

A Capgemini survey (October/November 2017) of digital assistant owners gave the following reasons for preferring a voice interface to a website or app: 1) it is more convenient (52%), 2) it allows me to multi-task and do things hands-free (48%), 3) it helps me automate my routine shopping task (41%), and 4) it feels like a more natural way to interact (37%). According to Wilson and Daugherty (2018), human creative, analytical and decision-making strengths can be amplified by using DA bots by providing the right information at the right time.

This article surveys the state-of-the-art voice decision bots. The next section summarizes current bot development environments, the tools, and methods. The third and fourth sections explore use cases for decision bots in both structured and semi-structured decision situations. In section 4, prospects for general-purpose decision bots are explored briefly. The final section draws conclusions and promotes the need for more design science research on DA bots.

DA BOT DEVELOPMENT

Agile development is often appropriate for DA bot development. The projects are usually of short duration and new environments support the rapid development of working software. There are multiple development chatbot tools. For example, Amazon Lex (Amazon.com, 2019) is a Cloud-based "service for building conversational interfaces into any application using voice and text. Amazon Lex provides the advanced deep learning functionalities of automatic speech recognition (ASR) for converting speech to text, and natural language understanding (NLU) to recognize the intent of the text, to enable you to build applications with highly engaging user experiences and lifelike conversational interactions." Amazon Lex uses the same technologies as Amazon Alexa and makes them available to developers to quickly build sophisticated, natural language, conversational bots."

One tool for building a chatbot is a decision logic tree. Lambert (2018) provides a brief description of a chatbot decision tree. He notes a "chat session is essentially a scripted series of questions and answers, leading to a diagnosis. So it could be implemented in a decision tree." He explains "At each node in the decision tree the system asks a typically multiple choice question and, based on the answer, branches to the next node." This approach narrows the problem space and helps formulate a useful response. In 1985, Power reviewed the symptoms, problems, and treatment question and answer framework to structure knowledge for building a management expert system. This framework is a classical way of diagnosing situations and arriving at conclusions. Table 1 summarizes several DA bot characteristics. Specific instances of bots would be a combination of characteristics along these continuums.

Category	**Characteristics Continuum**	
Purpose	● General	● Specific Domain
Conversational Interface	● Text-based	● Voice-based
Decision Type	● Complex Structured	● Semi-Structured
Knowledge Representation	● Decision Trees	● Quantitative
Primary Driver	● Data-driven	● Model-driven
Conversation Memory	● Stateless	● Stateful
Output	● Voice	● Voice and Visual

Table 1. DA Bots Characteristics

Chatbots can be simple and narrowly focused or more general purpose. They can be stateless or stateful. A stateless chatbot begins each conversation as if it was a new user. Conversely, a stateful chatbot can use data from past interactions and frame

new questions and answers in a historical context. In many ways, the most important decision related to implementing a chatbot is selecting the right natural language processing (NLP) engine. For example, if the targeted user interacts with the decision assistant through voice, then the chatbot requires a speech recognition engine. For more on this topic see Bunardzic (2016) and SearchCRM (2019).

Voice AI conversational interfaces for a decision assistant can provide input controls, navigational components, and help or informational components. Most importantly, Question and Answer dialogs can structure processes, diagnose situations, and clarify decision support needs. Voice AI interfaces can be very fast, intuitive, and efficient to use.

What is the best current development environment for a decision assistant voice bot? Currently, after some research and testing, it seems the best is the Google Assistant Developer Community Program with Dialogflow for helping with action taking and the Amazon Lex development environment for question-and-answer dialogs. Walker (2019) provides an overview of the chatbot initiatives of Facebook, Microsoft, Google, and Amazon.

A person writing dialogs for AI bots needs to understand the purpose of the bot and then create a branching contingent script that can be programmed. There are many websites with tips on writing good dialog for screenplays. Some tips derived from Rabin (2014) include: 1) make sure your dialogue fits the character, the persona, 2) a bot character should have a distinctive, recognizable speaking style, 3) arguing with the user is OK, but keep the dialog constructive, 4) actions determine intent, but we must focus on what the bot says to establish trust and good intent, 5) Never tell a user things he/she already knows, 6) don't be boring, some subtlety or nuance in the dialog may be good, 7) If the bot is the "star", have a strong concluding statement for the bot in the standard dialog.

The first step in designing a DA bot is to determine if a conversation design is appropriate for the advisory or decision task. Then define the intended users and their task environment. The who, what and when of using the DA bot. Next look for templates on development sites. Has something similar been developed? What is the persona, the tone, word choice speaking style, and personality of a DA bot? Create a high-level design of intentions and operations, the data that should be elicited, rules, and then create an ideal path for the DA bot dialog. Then write and test dialog. Finally, help the DA bot learn and have target users converse with the DA bot. Test, revise and test again. A DA bot advises or counsels.

Some authors have proposed developing conversational AI, which is a broader term than conversational decision support. Brenier (2018) explains that this term refers to using machine capabilities to understand and generate human language. Also, he identified decision support as one of four major high-level use cases for conversational AI. He notes one should "adopt conversational AI to walk users through a decision or task that might feel overwhelming." Focusing on conversational decision support helps keep the development focus on advising, assisting and counseling decision makers.

USE CASES IN COMPLEX, STRUCTURED SITUATIONS

Most of us are curious about how bots will actually be used, the use cases. Descriptions of use cases can help in selecting projects and in designing research studies. The use case categories may be narrow and concrete or more abstract and general. Exploring the range of uses is important. Some common use cases include: 1) answering routine customer questions, 2) providing IT Helpdesk functionality, 3) providing advice on topics like places to visit or things to do, and 4) guiding a customer through the process of filing an insurance claim. For example, liveperson.com sells "ready-to-go bot templates for industry-specific use cases which include pre-configured intents and dialogue flows along with necessary integrations into back-office systems." With advanced natural language processing capabilities, the software creates a conversational experience. Comm100 has an AI-powered Chatbot that helps customers get quick answers to simple queries, delivered in natural language and with the option to defer to an agent whenever needed (cf., comm100.com).

USE CASES IN SEMI-STRUCTURED SITUATIONS

Semi-structured decision situations include resource allocation, selection, and choice among predefined alternatives, problem-solving, and ranking and rating tasks. The phrase conversational, general-purpose decision support refers to a knowledge-driven software application with a voice interface that engages a person, a decision maker, in a question-and-answer dialog about a specific decision situation. A decision-structuring adviser should become more focused, and specific, as a decision maker responds to questions and hence adds structure. Think of a voice input computerized system that captures decision-relevant information and helps a decision maker organize and process the information, make judgments and assessments. In general, a conversational general-purpose DA bot participates in an informal chat where both parties share ideas or information. The conversation should be a "back and forth" -- the bot can ask and answer questions and so can the decision maker. As the conversations progress the probes or questions should follow a prescribed decision process.

One possibility is a conversational DA bot for weighted multi-criteria decision analysis (MCDA). The DA bot would provide broad, general-purpose decision support. Multi-criteria decision analysis (MCDA) is a general framework with wide

applicability for supporting complex decision-making situations with multiple and often conflicting objectives. Another possibility is to develop a complete decision process dialog from decision question formulation to finalizing a choice. The dialog would ask about criteria, weights, draw alternatives from brainstorming and the bot would help a person rate the alternatives on the criteria. The bot would provide help with sensitivity analysis and identify a dominant alternative if one existed.

Another general-purpose qualitative-choice model is Pro and Con comparisons for the two "best" alternatives. A DA bot would help a person compare the positive and negative aspects of identified alternatives. The bot might even help decision-makers rate the importance of each argument and calculate the sum of pros minus cons, cf., Power. (1977; 1998).

Perhaps technology limited or constrained the development and use of general-purpose decision advisers and now the constraint has been removed. Only further design science research can resolve that explanation.

CONCLUSIONS

The analytics and decision support community should conduct more empirical and design research related to chatbots and voice AI. Perhaps researchers can create interactive general-purpose decision process assistants. Perhaps start with investigating dedicated decision assistants that can help in call centers or provide improved support for phone consultations. Help people make specific routine decisions like what products to order or where to place a new facility. Conversational user interfaces (UI) are part of the future of decision support. Our imagination is the limit in creating innovative DA bot uses.

More prototypes, experimental bots, and design science projects are needed. Our goal is to develop and test both narrow specific decision bots and general purpose, conversational decision structuring voice bots. Bots over time and multiple decisions will learn the context and patterns of decision-making tasks. Decision support bots can and likely will be an assistant, a guide, and a tool to help a person make better, faster, more effective decisions.

User experience (UX) testing is required to improve the conversational dialog and capabilities. A decision adviser bot cannot be static, rather it must evolve its persona and abilities and learn about each individual person who uses it. A decision adviser should be a person-specific decision adviser. Perhaps a voice interface will help managers be more rigorous in semi-structured and ill-structured decision situations and improve decision quality (Aldag & Power, 1986; Power, Meyeraan, & Aldag, 1994).

Watson (2017), a decision support pioneer, noted in an article about preparing for the cognitive generation of decision support that "The relationships between chatbots and decision support are both obvious and subtle. The obvious relationship is the ability to acquire decision support-related information through a chatbot accessed while in a company's messaging system. …The more subtle relationship of chatbots with decision support is how customers decide to buy." Voice AI bots extend the possibilities.

This vision of developing a general-purpose Decision Adviser Voice Interface is challenging, complex, and still far from realization. Perhaps managers are not psychologically ready to talk with a computer-based decision adviser. Perhaps the development environment is still too primitive to capture the needed expertise from a human developer and then learn from interacting with users. Overall, more exploratory design science research is needed to improve our understanding of the design, development, and deployment of DA bots for use by various target users groups including clients, customers, employees, and managers.

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REFERENCES

1. Amazon.com (2019), "Amazon Lex Conversational interfaces for your applications powered by the same deep learning technologies as Alex," at URL https://aws.amazon.com/lex
2. Aldag, RJ and DJ Power (1986) "An empirical assessment of computer-assisted decision analysis," Decision Sciences, 17 (4), 572-588.
3. Brenier, J. (2018) "What Is Conversational AI?" Georgian Partners, February 15 at URL https://georgianpartners.com/what-is-conversational-ai/

4. Bunardzic, A. (2016) "How To Build A Stateful Bot," Medium.com, July 12 at URL https://medium.com/bots-for-business/how-to-build-a-stateful-bot-a2703ff2d57b
5. Capgemini Digital Transformation Institute (2017) "Conversational Commerce Survey," October–November.
6. Lambert, M. (2018) "Chatbot Decision Trees: Seriously, how hard can they be?" Chatbot magazine, April 21 at URL https://chatbotsmagazine.com/chatbot-decision-trees-a42ed8b8cf32
7. Power, D. J. (01/06/2019) "Can chatbot technology improve decision support?" Decision Support News, Vol. 20, No. 1, 01/06/2019 at URL http://dssresources.com/newsletters/488.php .
8. Power, D. J. (02/17/2019) "What is conversational, general-purpose decision support?" Vol. 20, No. 4, at URL http://dssresources.com/newsletters/491.php .
9. Power, D.J. (1977) "Design and development of DECAID: a CAL decision formulation program," Masters Thesis, University of Iowa, 221 pages at URL https://ir.uiowa.edu/cgi/viewcontent.cgi?article=7374&context=etd and https://doi.org/10.17077/etd.f85zyx13.
10. Power, D.J. (1998) "Designing and Developing A Computerized Decision Aid - A Case Study," unpublished working paper, version 2.0, April 14, 1998, at http://www.dssresources.com/papers/decisionaids.html
11. Power, D.J. (1985) "Using the Symptoms, Problems and Treatment Framework to Structure Knowledge for Management Expert Systems," In Methlie, L., and Sprague, R. (Ed.), Knowledge Representation for Decision Support Systems, New York: North-Holland Publishing Co., pps. 245-254.
12. Power, DJ, SL Meyeraan, RJ Aldag(1994) "Impacts of problem structure and computerized decision aids on decision attitudes and behaviors," Information & Management, 26 (5), 281-294.
13. PR Newswire (2018), "IDTechEx Latest Research on Voice, Speech, Conversation-Based User Interface 2019-2029," at https://www.prnewswire.com/news-releases/idtechex-latest-research-on-voice-speech-conversation-based-user-interface-2019-2029-300756913.html
14. Rabin, S. (2014) "How to Write Great Dialogue," Final Draft Blog, October 8 at URL https://www.finaldraft.com/learn/final-draft-blog/write-great-dialogue/
15. SearchCRM (2019), "Chatbot", at URL https://searchcrm.techtarget.com/definition/chatbot
16. Walker, J. (2019) "Chatbot Comparison - Facebook, Microsoft, Amazon, and Google," EMERJ, January 29 at URL https://emerj.com/ai-sector-overviews/chatbot-comparison-facebook-microsoft-amazon-google/
17. Watson, H. J. (2017) "Preparing for the Cognitive Generation of Decision Support," MIS Quarterly Executive, volume 16, number 3, September.
18. Wilson, H. J., and P.R. Daugherty, P R. (2018) Collaborative intelligence: humans and AI are joining forces, Harvard Business Review, 2018, Vol.96(4), p.114(10)